

US Patent Application for:

2 Eight-Stroke Internal Combustion Engine Utilizing A Slave Cylinder

4 **ABSTRACT**

By the utilizing of a slave cylinder working in coordination with a master cylinder,
6 the slave cylinder both receives cool atmospheric air and receives hot, partially
un-burnt exhaust gases from the master cylinder to create a second power-
8 stroke in the slave cylinder. With the two coordinating cylinders, the entire
working process is from 0 to 810 degrees of revolution crankshaft. The master
10 cylinder cycles work from 0 to 720 degrees of revolution and slave cylinder
cycles work from 90 to 810 degrees of revolution. The master cylinder begins to
12 intake air and fuel at 0 degree of revolution and slave cylinder begins to intake air
at 90 degrees of revolution. There is an angle of 60 -120 degrees differences
14 between master and slave cylinder, where the slave cylinder is trailing the
master.

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FIELD

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The present invention is related to an eight-stroke internal combustion engine,
20 which may be used in most any application of present uses of internal
combustion engines, such as a transportation vehicle. More specifically this
22 invention relates to an eight-stroke reciprocating piston driven internal
combustion engine utilizing a slave cylinder working in cooperation with a master
24 cylinder.

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BACKGROUND OF THE INVENTION

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There are two main types of piston driven reciprocal internal combustion engines,
30 they are the spark ignition engines, and the auto-ignition engines, also called
diesel engines.

2 These piston driven reciprocal engines, for the most part, use either a two-stroke
4 cycle or more commonly, a four-stroke cycle. The main parts of these engines
6 are; a cylinder containing a piston with a reciprocal movement which is converted
8 into a rotational movement by means of a connecting rod and a crankshaft, and a
10 cylinder head consisting of at least two valves, one exhaust valve and one intake
12 valve. The four stroke or four cycle engine begins by the piston drawing an
14 atomized air-fuel mixture into the cylinder through the intake valve on the first
16 down stroke, the first cycle; then with the valves closed the mixed gases are
18 compressed on the first up stroke, the second cycle; and at or near the top of the
20 first up stroke, the compressed mixture of air and fuel ignites, by either a spark or
22 by auto-ignition, and the mixture, or most of the gas mixture, combusts to
24 produce a second downward stroke the third cycle, which is the power stroke; the
26 second upward stroke, the fourth cycle, pushes the burnt gas mixture and the
28 remaining un-burned gas mixture out of an open exhaust valve to complete the
30 fourth cycle where the rotary or centrifugal motion created by the process is
carried by the flywheel for the cycles to continue until either the fuel is shut off or
the spark is discontinued.

20 The efficiency of the energy produced depends, among other variables, on the
amount of air-fuel mixture drawn or forced into the cylinder and the compression
22 volume ratio. The higher the compression volume ratio, the higher the efficiency.
The compression volume ratio is limited, in the case of the gasoline engine, by
24 the risk of premature ignition of the mixture and in the case of the diesel engine
among other variables, by a sturdy and appropriate combustion chamber.

26 It is well known that four-cycle and other multi-cycle internal combustion engines
28 produce exhaust gases that contain un-used energy in the form of un-burnt
gasses. Many different approaches have been used to both try to capture the un-
30 used energy within these unburned gases and to try to reduce atmospheric
emissions caused by inefficient combustion.

2 Inventor is aware of United States Patent 4,917,054 issued to Schmitz on April
17, 1990, "Six-stroke internal combustion engine". This is a reciprocating pistons
4 engine, wherein six strokes used, they are the admission of air, the first
compression accompanied or followed by a possible cooling, a second
6 compression followed by a combustion, the first expansion producing a usable
work, the second expansion producing usable work and finally the discharge of
8 the combustion gases.

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SUMMARY OF THE INVENTION

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It is therefore an object of the present invention is to produce an eight-stroke
14 reciprocating piston internal combustion engine with increased fuel efficiency.

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Another object of the present invention, is to produce an eight-stroke
reciprocating piston internal combustion engine which is less polluting.

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By the use of a slave cylinder working in coordination with a master cylinder, the
20 slave cylinder both receives cool atmospheric air and receives hot combustion
gases from the master cylinder to create a second power-stroke in the slave
22 cylinder. The increased compression ratio of air in the slave cylinder, allows
compressed air to be injected into the master cylinder as the master cylinder is in
24 the later half of it's power stroke, this causes a re-burn of the combustion gasses
in the master cylinder. This secondary combustion is transferred from the master
26 cylinder, through the coordinate valve to the slave cylinder to produce a second
power stroke within the slave cylinder.

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The lower temperature in the slave cylinder makes it possible, by heat transfer, to
30 substantially take full advantage of the heat energy created in the master
cylinder.

2 With the two coordinating cylinders, the master cylinder and the slave cylinder,
4 there are eight working cycles or strokes, each within 90° of crankshaft revolution
6 of each other. The entire working process is from 0° to 810° of revolution
8 crankshaft. The master cylinder cycles work from 0° to 720° of revolution and
10 slave cylinder cycles work from 90° to 810° of revolution. The master cylinder
12 begins to intake air and fuel at 0 degree of revolution and slave cylinder begins to
14 intake air at 90° of revolution.

16 In a conventional internal combustion engine, the engine metal will absorb the
18 heat energy produced by combustion, and the cylinder will be cooled down by
20 the cooling system. Resulting in wasted heat energy. The eight-stroke piston
22 engine uses cold air in the slave cylinder to combine with the "wasted" heat
24 energy to produce power as when the cool air combines with the heat energy
26 and un-burnt gases, the cool air inside the slave cylinder will expand. Therefore,
28 the expanded air will continue the power cycle within the master cylinder by
30 combusting most of the remaining un-burnt gases and as the master cylinder
exhaust, it also produces a second power cycle within the slave cylinder without
a spark.

The heat energy and un-burnt gases from the master cylinder will combine with
the cool air in the slave cylinder. This will reduce the temperature in the master
cylinder lowering the chance of pre-ignition detonation, thus allowing higher
compression ratios and will also result in higher thermal efficiency, as the cooler
slave cylinder air absorbs the heat energy and the engine metal will absorb less
heat.

Therefore, the embodiment of this invention is an internal combustion engine
composed essentially of at least one pair of compressing cylinders. It is plausible
that the master cylinder and the slave cylinder could be substantially more or
substantially less than 90° off rotation of each other. For ease of explaining this

invention the cylinders are discussed herein working 90° off rotation of each

2 other.

4 It is also plausible that the master cylinder could potentially use a third valve, an
6 exhaust valve to the outside if required. As well it is plausible that the slave
8 cylinder could potentially use a third valve giving more control to the coordinate
10 valve port if required. It is also plausible, the displacement of the master cylinder
12 and slave cylinder could be different. As well, the duration of the valve timing
may be varied depending on the application requirements and variables in the
engine tuning dynamics. It is further plausible wherein this engine has more than
one said slave cylinder for each said master cylinder, or more than one master
cylinder for each slave cylinder. It is still further plausible wherein this engine's
second power stroke is assisted by introduction of a light fuel such as hydrogen.

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16 In theory, the principle of this eight-stroke internal combustion engine can be
18 applied to both the spark ignition engine and the auto-ignition or diesel engine,
and the invention could plausibly use a spark in the slave cylinder if so desired.

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20 BREIF DESCRIPTION OF THE DRAWINGS

22 Various other objects, features and advantages of the present invention will
24 become more fully appreciated as the same becomes better understood when
26 considered in conjunction with the following detailed description of an illustrative
embodiment and the accompanying drawings, in which like reference characters
designate the same or similar parts throughout the several views, and wherein;

28 FIGS. 1 to 8 are progressive engine strokes from one to eight shown in a
sectional elevation view of the engine,

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FIG. 1 shows the master cylinder intake, stroke #1, at beginning of the strok and

the slave cylinder is in the middle of its exhaust, stroke #8.

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FIG. 2 shows the master cylinder intake, stroke #1, at the middle of the stroke
4 and the slave cylinder is finishing its exhaust, stroke #8.

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FIG. 3 shows the master cylinder compression, stroke #3, at the beginning of the
stroke and the slave cylinder is in the middle of intake, stroke #2.

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FIG. 4 shows master cylinder compression, stroke #3, at the middle of the stroke
10 and the slave cylinder is in the end of intake, stroke #2.

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FIG. 5 shows master cylinder ignition, stroke #5, at the beginning of the power
stroke and the slave cylinder is in the middle of compression, stroke #4.

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FIG. 6 shows master cylinder combustion, stroke #5, at the middle of the power
16 stroke and the slave cylinder is at the top of compression, stroke #.

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FIG. 7 shows master cylinder exhaust, stroke #7, at the beginning of the exhaust
stroke and the slave cylinder is in the middle of the power stroke, stroke #6.

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FIG. 8 shows master cylinder exhaust, stroke #7, at the middle of the exhaust
22 stroke and the slave cylinder is at the end of the power stroke, stroke #6.

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FIG. 9 shows a diagram of the eight-stroke engine working cycles.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

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The eight-stroke internal combustion engine is generally referred to as 10, it is
30 shown in a cutaway sectional elevation view, where engine 10 comprises a

cylinder block 12, and within block 12, there is a master cylinder bore 14 and a
2 slave cylinder bore 16.

4 The master cylinder 14 contains a piston 18 which is slidable movable by
connecting rod assembly 20, rod 20 is rotationally supported by crankshaft 22,
6 where crankshaft 22 is rotationally supported by cylinder block 12. Slave cylinder
bore 16 contains a piston 24 which is slidable movable by connecting rod
8 assembly 26, rod 26 is also rotationally supported by crankshaft 22.

10 Fixed atop cylinder block 12 is a cylinder head 28. Above master cylinder 14,
cylinder head 28 includes a spark plug 30, an intake valve 32 and a coordinate
12 valve 34. Above slave cylinder 16, cylinder head 22 includes an open port 36 to
coordinate valve 34, an intake valve 38 and an exhaust valve 40.

14 As seen in FIG. 1, intake stroke, stroke #1, is at the beginning (0°) of the
16 crankshaft 22 rotation cycle. During rotation, master cylinder 14 intakes air and
fuel (A/F) through the master cylinder intake valve 32. At this rotational position
18 the slave cylinder piston 24, is in the middle of its exhaust stroke, stroke #8.

20 As seen in FIG. 2, intake, stroke #1, is at the middle (90°) of rotation, where the
master cylinder 14 intakes A/F through the master cylinder intake valve 32 and
22 slave cylinder 16 is finishing its exhaust stroke, stroke #8 (810° of its cycle
rotation completion, or the beginning of a new cycle of rotation).

24 As seen in FIG. 3 the master cylinder 14 compression, stroke #3, at the
beginning of the stroke (180° of its cycle rotation), where the master cylinder 14
26 begins compresses A/F and the slave cylinder piston 24 is in the middle of
28 intake, stroke #2, induction of Air only.

30 As seen in FIG. 4 master cylinder 14 compression stroke #3, at the middle of the
stroke (270° of its cycle rotation), where the master cylinder piston 18 continues

compression of A/F and the slave cylinder 16 is in the end of intake, stroke #2.

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As seen in FIG. 5 shows master cylinder 14, upon sparkplug 30 ignition, stroke #5, at the beginning of the power stroke (360° of cycle rotation), where the master cylinder 14 begins combustion of A/F and the slave cylinder piston 24 is in the middle of compression, stroke #4, where the slave cylinder compresses Air only.

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As seen in FIG. 6 master cylinder combustion, stroke #5, at the middle of the power stroke (450° of cycle rotation), where the master cylinder's coordinate valve 34 is already opening (the air from slave cylinder is pushed into master cylinder at about 420 degrees, close to the end of Stroke #4) and the slave cylinder piston 24 is at the top of compression, stroke #4 where the slave cylinder's compressed Air is mixed with combustion gases in master cylinder 14.

16 As seen in FIG. 7 master cylinder 14 exhaust, stroke #7, at the beginning of the exhaust stroke (540° of cycle rotation), where the master cylinder 14 begins to exhaust combustion gases through the coordinate valve and the slave cylinder piston 24 is in the middle of the power stroke, stroke #6, where the slave cylinder 16 continues power stroke as the gases expand and are re-burned within both master cylinder 14 as it exhausts through coordinate valve and into slave cylinder 16 as slave cylinder piston 24 continues its power stroke.

24 As seen in FIG. 8 where in master cylinder 14, the master cylinder piston 18 is at the middle of the exhaust stroke, stroke #7, (630° of cycle rotation), where the master cylinder piston 18 continues to exhaust combustion gases through the coordinate valve 34 and the slave cylinder 16 is at the end of the power stroke, stroke #6, where the slave cylinder continues to accept the combustion gases from the master cylinder through coordinate valve 34 until coordinate valve 34 closes before the next intake cycle begins.